US009454239B2

(12) **United States Patent**
Elias

(10) **Patent No.: US 9,454,239 B2**
(45) **Date of Patent: *Sep. 27, 2016**

(54) **ENABLING TOUCH EVENTS ON A TOUCH SENSITIVE MECHANICAL KEYBOARD**

(75) Inventor: **John Greer Elias**, Townsend, DE (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 832 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/232,941**

(22) Filed: **Sep. 14, 2011**

(65) **Prior Publication Data**

US 2013/0063285 A1 Mar. 14, 2013

(51) **Int. Cl.**

H03K 17/94	(2006.01)
H03M 11/00	(2006.01)
G06F 3/041	(2006.01)
G06F 3/02	(2006.01)
G09G 5/00	(2006.01)
G06F 3/038	(2013.01)
G06F 3/0354	(2013.01)
G06F 3/044	(2006.01)

(52) **U.S. Cl.**

CPC ***G06F 3/0213*** (2013.01); ***G06F 3/038*** (2013.01); ***G06F 3/03547*** (2013.01); *G06F 3/044* (2013.01)

(58) **Field of Classification Search**

CPC G06F 3/0202; G06F 3/02; G06F 3/04

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,188,136	A	2/1980	Bedocs
4,417,294	A	11/1983	Herron, Jr.
5,189,403	A	2/1993	Franz et al.
5,269,004	A	12/1993	Comerford et al.
5,341,133	A	8/1994	Savoy et al.
5,483,261	A	1/1996	Yasutake
5,488,204	A	1/1996	Mead et al.
5,581,243	A	12/1996	Ouellette et al.
5,675,361	A	10/1997	Santilli

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1882904 A	12/2006
EP	1 653 338 A1	5/2006

(Continued)

OTHER PUBLICATIONS

Anonymous. (2008). TouchStream LP User Interface Descriptions, located at http://fingerworks.com/ST_product.html, last visited Nov. 13, 2008, 24 pages total (submitted 14 pages).

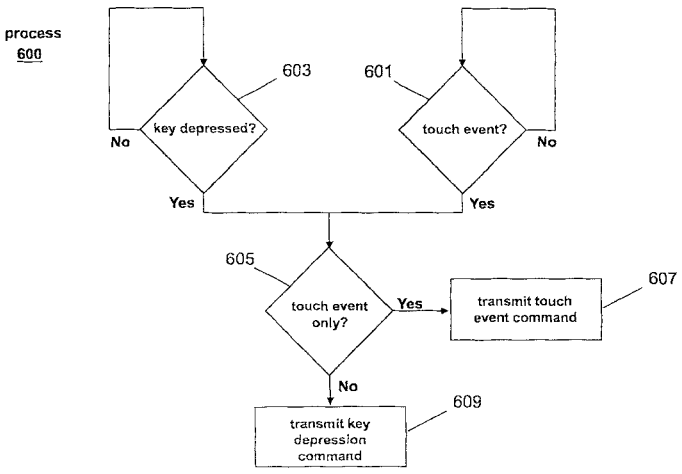
(Continued)

Primary Examiner — Muhammad N Edun
Assistant Examiner — Jerold Murphy
(74) *Attorney, Agent, or Firm* — Morrison & Foerster LLP

(57) **ABSTRACT**

Touch sensitive mechanical keyboards and processes for detecting touch events and key depressions on the touch sensitive mechanical keyboard are provided. The touch sensitive mechanical keyboard can include a set of individually depressible mechanical keys having a touch sensitive area located on their surface. A touch sensor can be included to detect touch events on the surface of the mechanical keys. A keypad can also be included to detect a depression of the mechanical keys. The touch sensitive mechanical keyboard can further include a processor for distinguishing detected touch events from detected key depressions. The processor can generate either a key depression command or a touch event command.

14 Claims, 7 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

5,707,160	A	1/1998	Bowen	
5,736,976	A	4/1998	Cheung	
5,821,922	A	10/1998	Sellers	
5,825,352	A	10/1998	Bisset et al.	
5,835,079	A	11/1998	Shieh	
5,880,411	A	3/1999	Gillespie et al.	
5,982,302	A	11/1999	Ure	
6,188,391	B1	2/2001	Seely et al.	
6,204,839	B1	3/2001	Mato, Jr.	
6,310,610	B1	10/2001	Beaton et al.	
6,323,846	B1	11/2001	Westerman et al.	
6,504,530	B1	1/2003	Wilson et al.	
6,529,186	B1	3/2003	Thayer	
6,690,387	B2	2/2004	Zimmerman et al.	
7,015,894	B2	3/2006	Morohoshi	
7,184,064	B2	2/2007	Zimmerman et al.	
7,428,142	B1	9/2008	Ligtenberg et al.	
7,659,887	B2 *	2/2010	Larsen et al.	345/170
7,663,607	B2	2/2010	Hotelling et al.	
7,952,038	B1	5/2011	Ando et al.	
7,952,566	B2	5/2011	Poupyrev et al.	
8,479,122	B2	7/2013	Hotelling et al.	
8,581,870	B2	11/2013	Bokma et al.	
8,933,905	B2	1/2015	Bokma et al.	
9,041,652	B2 *	5/2015	Elias	G06F 3/044 341/22
2002/0171633	A1	11/2002	Brinjes	
2002/0175901	A1	11/2002	Gettemy	
2003/0025679	A1	2/2003	Taylor et al.	
2003/0201982	A1	10/2003	Iesaka	
2004/0183786	A1	9/2004	Jam	
2005/0262882	A1	12/2005	Moon	
2006/0026521	A1	2/2006	Hotelling et al.	
2006/0187212	A1	8/2006	Park et al.	
2006/0197753	A1	9/2006	Hotelling	
2006/0232557	A1	10/2006	Fallot-Burghardt	
2006/0238510	A1	10/2006	Panotopoulos et al.	
2007/0063976	A1	3/2007	Oga	
2007/0120828	A1	5/2007	Fyke	
2007/0146334	A1	6/2007	Inokawa	
2007/0152975	A1	7/2007	Ogihara et al.	
2008/0006453	A1	1/2008	Hotelling	
2008/0024459	A1 *	1/2008	Poupyrev	G06F 3/016 345/173
2008/0106519	A1 *	5/2008	Murray	G06F 1/1626 345/169
2008/0158172	A1	7/2008	Hotelling et al.	
2008/0158181	A1	7/2008	Hamblin et al.	
2008/0202824	A1	8/2008	Philipp et al.	
2008/0225006	A1	9/2008	Ennadi	
2008/0297475	A1	12/2008	Woolf et al.	
2008/0309522	A1	12/2008	Larsen et al.	
2009/0000936	A1	1/2009	Steijner	
2009/0002199	A1	1/2009	Lainonen et al.	
2009/0027347	A1	1/2009	Wakefield et al.	
2009/0091536	A1 *	4/2009	Callaghan	345/168
2009/0128503	A1	5/2009	Grant et al.	
2009/0160785	A1	6/2009	Chen et al.	
2009/0210568	A1	8/2009	Peterson et al.	
2009/0314621	A1	12/2009	Hotelling	
2010/0053087	A1	3/2010	Dai et al.	
2010/0059294	A1	3/2010	Elias et al.	
2010/0079309	A1	4/2010	Filson et al.	
2010/0123676	A1	5/2010	Kirkup	
2010/0148995	A1 *	6/2010	Elias	341/22
2010/0149108	A1	6/2010	Hotelling et al.	
2010/0177057	A1	7/2010	Flint et al.	
2010/0259482	A1 *	10/2010	Ball	345/168
2010/0271315	A1 *	10/2010	Bathiche	G06F 3/0202 345/173
2010/0273534	A1 *	10/2010	Strom	455/566
2011/0001706	A1	1/2011	Sanford et al.	
2011/0141052	A1	6/2011	Bernstein et al.	
2011/0163971	A1	7/2011	Wagner et al.	
2011/0167375	A1	7/2011	Kocienda	
2011/0169765	A1	7/2011	Aono	
2011/0193817	A1	8/2011	Byun et al.	
2011/0227854	A1	9/2011	Koya	
2011/0233041	A1	9/2011	Rajagopal et al.	
2011/0241997	A1	10/2011	Yang	
2011/0267287	A1	11/2011	Bartling et al.	
2012/0256839	A1	10/2012	Suggs	
2013/0063286	A1	3/2013	Elias et al.	
2013/0063356	A1	3/2013	Martisauskas	
2013/0141342	A1	6/2013	Bokma et al.	
2014/0035856	A1	2/2014	Bokma et al.	
2015/0091867	A1	4/2015	Bokma et al.	

FOREIGN PATENT DOCUMENTS

JP	2000-163031	A	6/2000
JP	2002-342033	A	11/2002
KR	10-0617821	B1	8/2006
KR	10-2008-0023871	A	3/2008
KR	10-2009-0002648	A	1/2009
TW	201135568	A	10/2011
TW	201142685	A	12/2011
WO	WO-2011/018439	A1	2/2011
WO	WO-2013/039698	A1	3/2013
WO	WO-2013/085580	A1	6/2013

OTHER PUBLICATIONS

Non-Final Office Action mailed Oct. 6, 2011, for U.S. Appl. No. 12/333,793, filed Dec. 12, 2008, 16 pages.

Pash, A. (Nov. 7, 2006). "Hack Attack: Operate Your Mouse with Your Keyboard," *Lifehacker*, located at http://lifehacker.com/software/mouser/hack-attack-operate-your-own-mouse-with-your-keyboard-212816.php, last visited Nov. 10, 2008, seven pages (submitted four pages.).

Non-Final Office Action mailed Mar. 10, 2014, for U.S. Appl. No. 13/232,968, filed Sep. 14, 2011, 24 pages.

Final Office Action mailed Oct. 16, 2012, for U.S. Appl. No. 12/334,320, filed Dec. 12, 2008, 31 pages.

Lee, S.K. et al. (Apr. 1985). "A Multi-Touch Three Dimensional Touch-Sensitive Tablet," *Proceedings of CHI: ACM Conference on Human Factors in Computing Systems*, pp. 21-25.

Rubine, D.H. (Dec. 1991). "The Automatic Recognition of Gestures," CMU-CS-91-202, Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Computer Science at Carnegie Mellon University, 285 pages.

Rubine, D.H. (May 1992). "Combining Gestures and Direct Manipulation," CHI ' 92, pp. 659-660.

Westerman, W. (Spring 1999). "Hand Tracking, Finger Identification, and Chordic Manipulation on a Multi-Touch Surface," A Dissertation Submitted to the Faculty of the University of Delaware in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Electrical Engineering, 364 pages.

International Search Report mailed Dec. 5, 2012, for PCT Application No. PCT/US2012/052929, filed Aug. 29, 2012, four pages.

Final Office Action mailed Sep. 26, 2013, for U.S. Appl. No. 13/232,968, filed Sep. 14, 2011, 21 pages.

Non-Final Office Action mailed Dec. 13, 2013, for U.S. Appl. No. 14/050,103, filed Oct. 9, 2013, 8 pages.

Search Report for ROC (Taiwan) Patent Application No. 101134042, mailed Oct. 29, 2013, English Translation, one page.

Non-Final Office Action mailed Apr. 27, 2012, for U.S. Appl. No. 12/334,320, filed Dec. 12, 2008, 25 pages.

Final office Action mailed Sep. 17, 2013, for U.S. Appl. No. 12/333,793 filed Dec. 12, 2008, 20 pages.

Non-Final office Action mailed Apr. 15, 2013, for U.S. Appl. No. 12/333,793, filed Dec. 12, 2008, 19 pages.

Non-Final Office Action mailed May 9, 2013, for U.S. Appl. No. 13/232,968, filed Sep. 14, 2011, 21 pages.

Non-Final Office Action mailed Aug. 14, 2013, for U.S. Appl. No. 12/334,320, filed Dec. 12, 2008, 37 pages.

Notice of Allowance mailed Jul. 18, 2013, for U.S. Appl. No. 13/312,803, filed Dec. 6, 2011, 8 pages.

Final Office Action mailed Mar. 9, 2012, for U.S. Appl. No. 12/333,793, filed Dec. 12, 2008, 20 pages.

(56) **References Cited**

OTHER PUBLICATIONS

International Search Report mailed Dec. 19, 2012, for PCT Application No. PCT/US2012/053109, filed Aug. 30, 2012, three pages.
Final Office Action mailed Jun. 4, 2014, for U.S. Appl. No. 14/050,103, filed Oct. 9, 2013, 11 pages.
Non-Final office Action mailed May 22, 2014, for U.S. Appl. No. 12/333,793, filed Dec. 12, 2008, 24 pages.
Non-Final Office Action mailed Aug. 12, 2014, for U.S. Appl. No. 13/232,955, filed Sep. 14, 2011, eight pages.
Final Office Action mailed Oct. 2, 2014, for U.S. Appl. No. 13/232,968, filed Sep. 14, 2011, 25 pages.
Final Office Action mailed Nov. 3, 2014, for U.S. Appl. No. 12/333,793, filed Dec. 12, 2008, 24 pages.
Notice of Allowance mailed Sep. 10, 2014, for U.S. Appl. No. 14/050,103, filed Oct. 9, 2013, seven pages.
Notice of Allowance mailed Jan. 23, 2015, for U.S. Appl. No. 13/232,955, filed Sep. 14, 2011, six pages.
Non-Final Office Action mailed Sep. 25, 2015, for U.S. Appl. No. 14/564,735, filed Dec. 9, 2014, 15 pages.
Chinese Search Report dated Mar. 8, 2016 for CN Application No. 201280057957.9, with English translation, four pages.
Notice of Allowance mailed Mar. 28, 2016, for U.S. Appl. No. 14/564,735, filed Dec. 9, 2014, five pages.

* cited by examiner

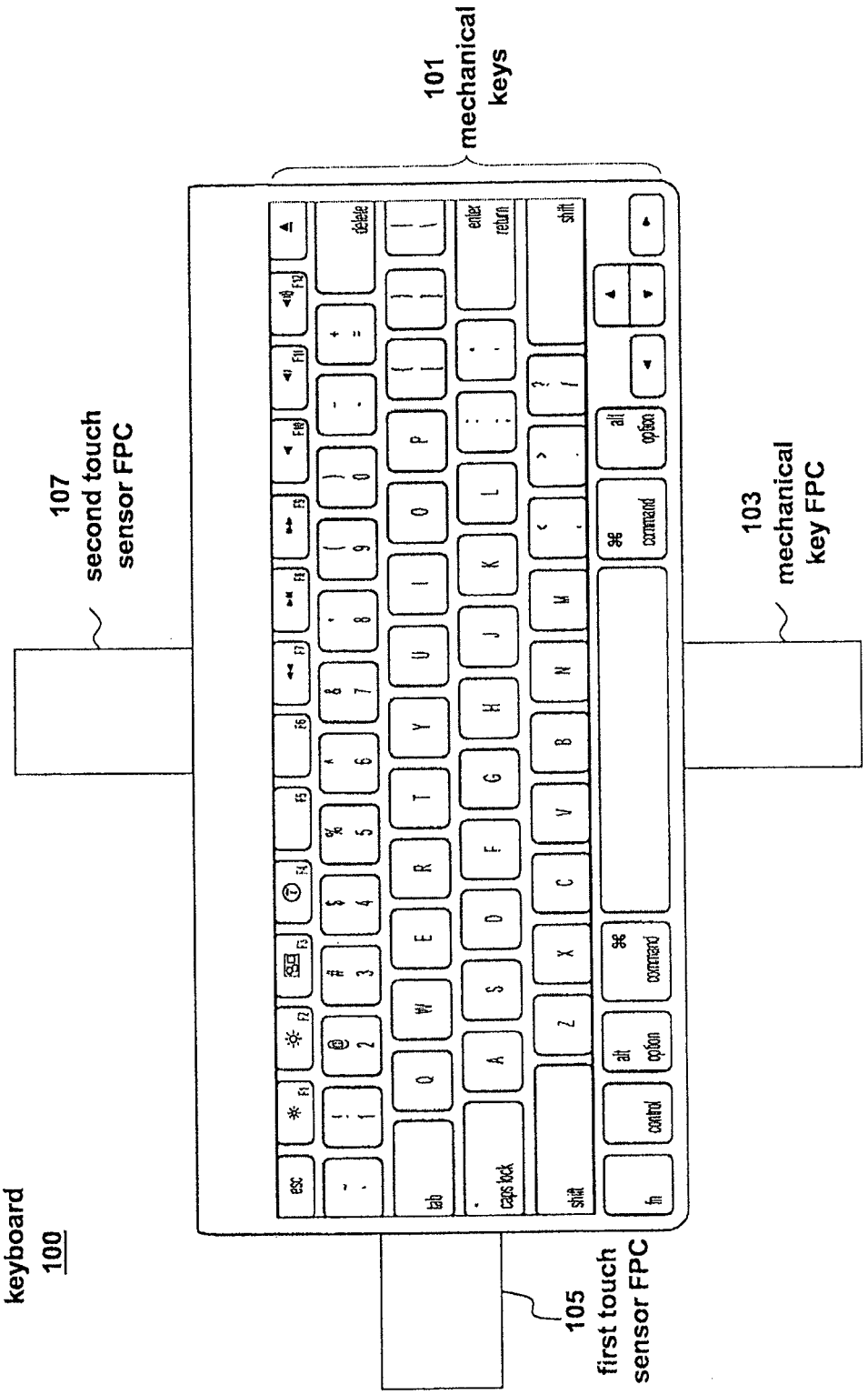

keyboard
100
101
mechanical
keys
107
second touch
sensor FPC
103
mechanical
key FPC
105
first touch
sensor FPC

FIG. 1

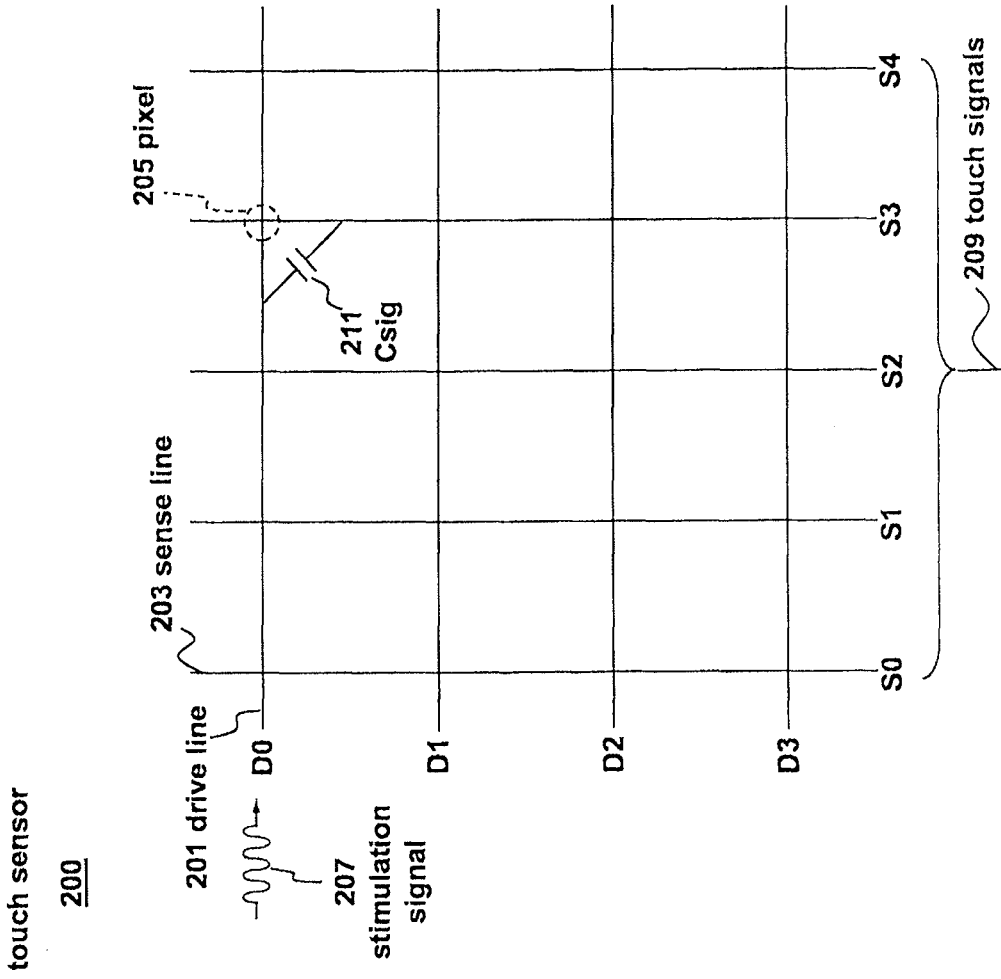

touch sensor
200
201 drive line
203 sense line
205 pixel
207 stimulation signal
211 Csig
209 touch signals
D0
D1
D2
D3
S0
S1
S2
S3
S4

FIG. 2

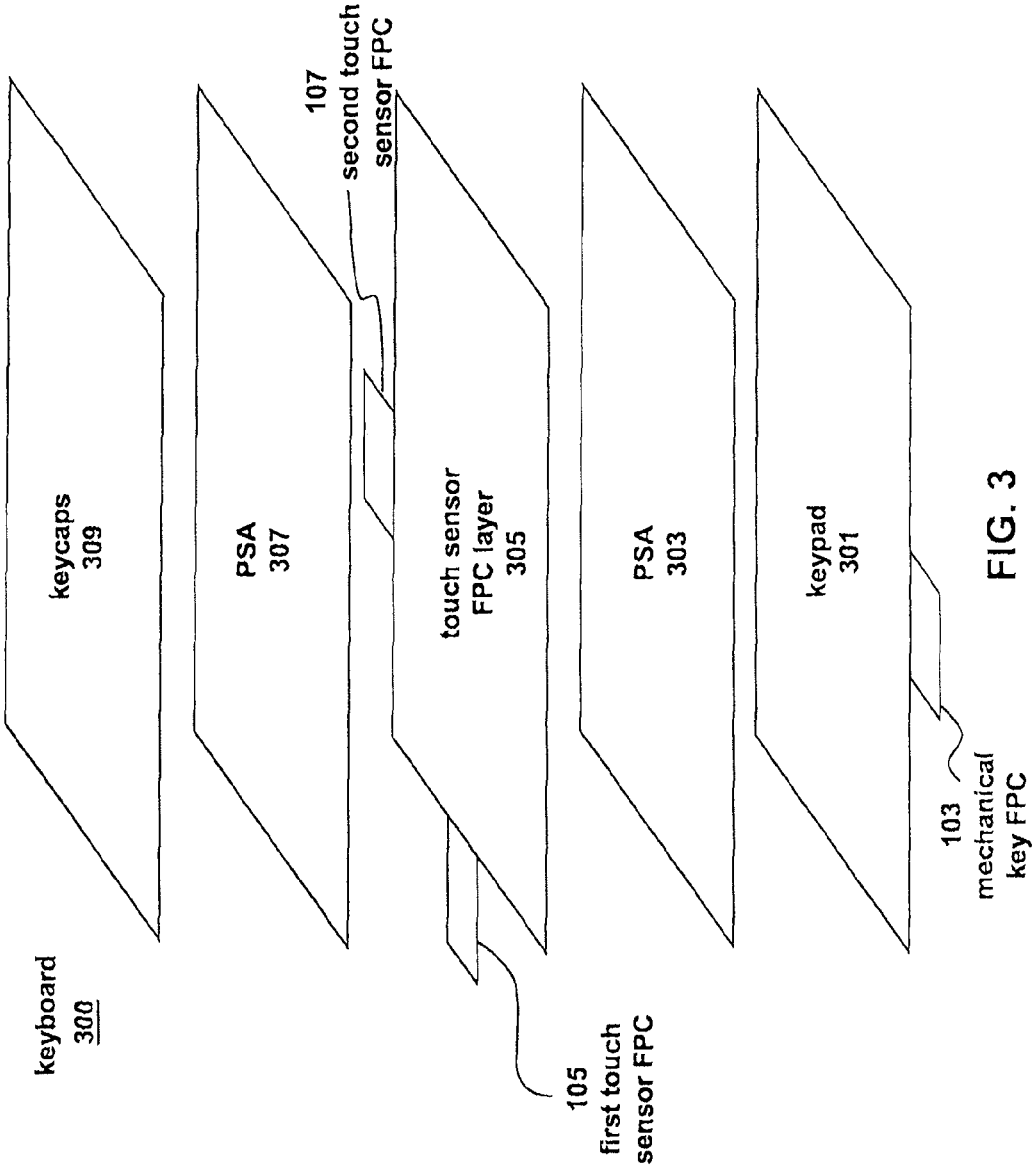

keyboard
300
keycaps
309
PSA
307
107
second touch
sensor FPC
touch sensor
FPC layer
305
PSA
303
keypad
301
105
first touch
sensor FPC
103
mechanical
key FPC

FIG. 3

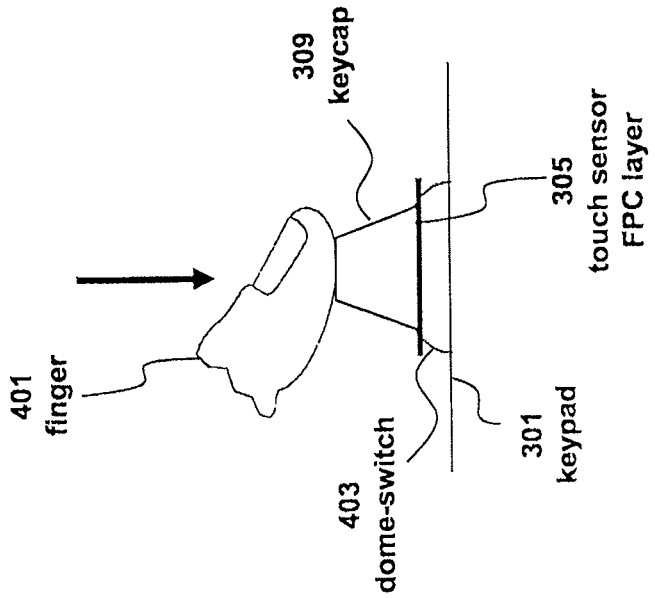

309
keycap
305
touch sensor
FPC layer
401
finger
403
dome-switch
301
keypad

FIG. 5

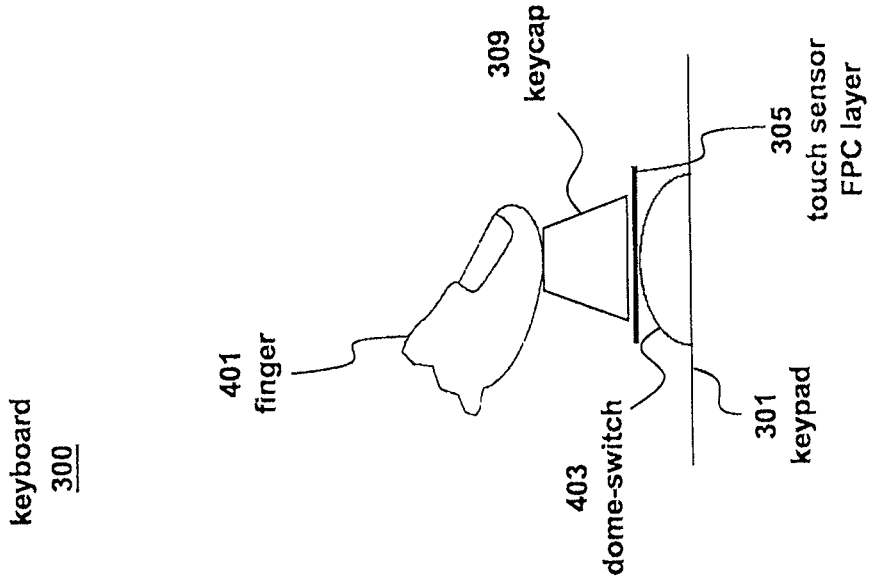

keyboard
300
309
keycap
305
touch sensor
FPC layer
401
finger
403
dome-switch
301
keypad

FIG. 4

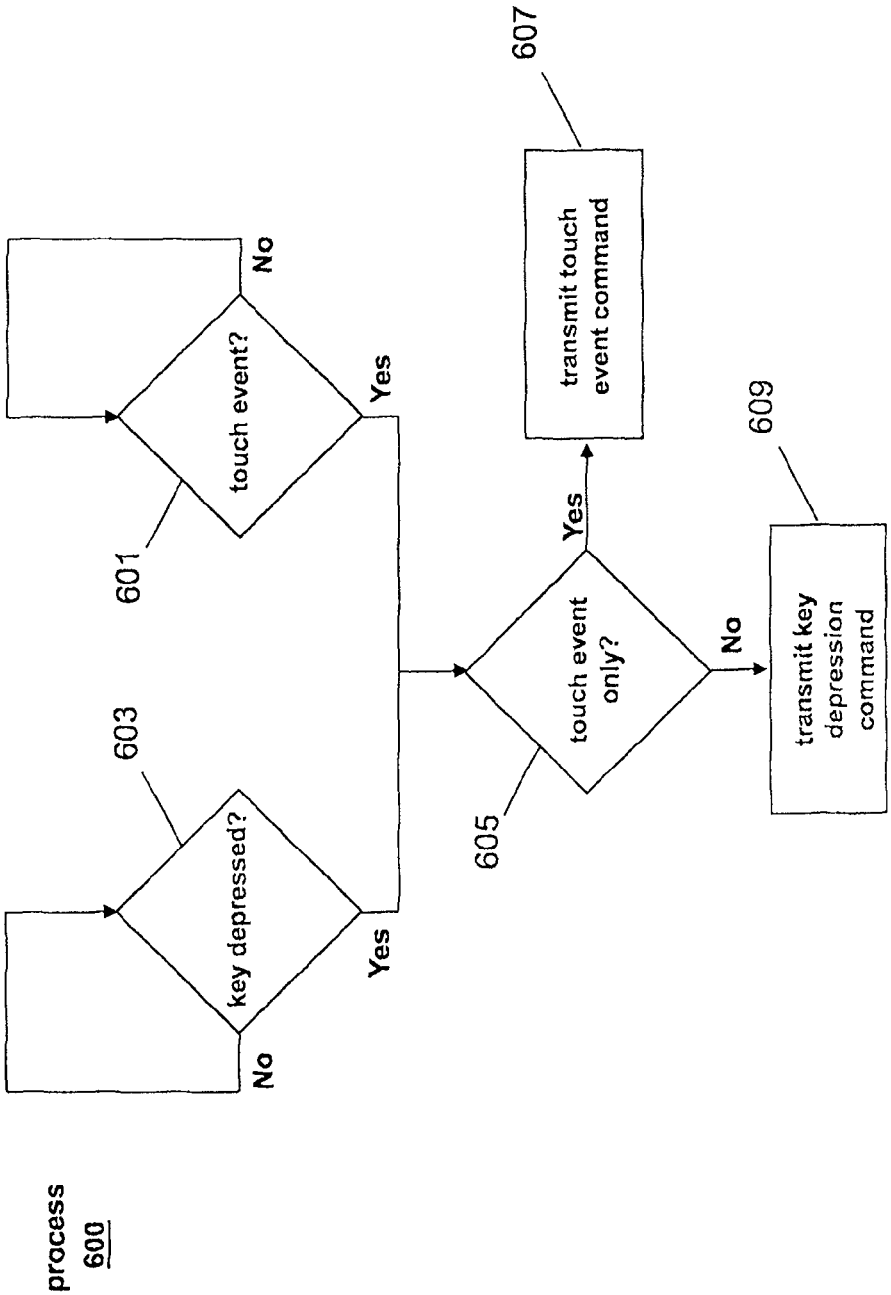

process
600
601
touch event?
No
Yes
603
key depressed?
No
Yes
605
touch event only?
Yes
No
607
transmit touch event command
609
transmit key depression command

FIG. 6

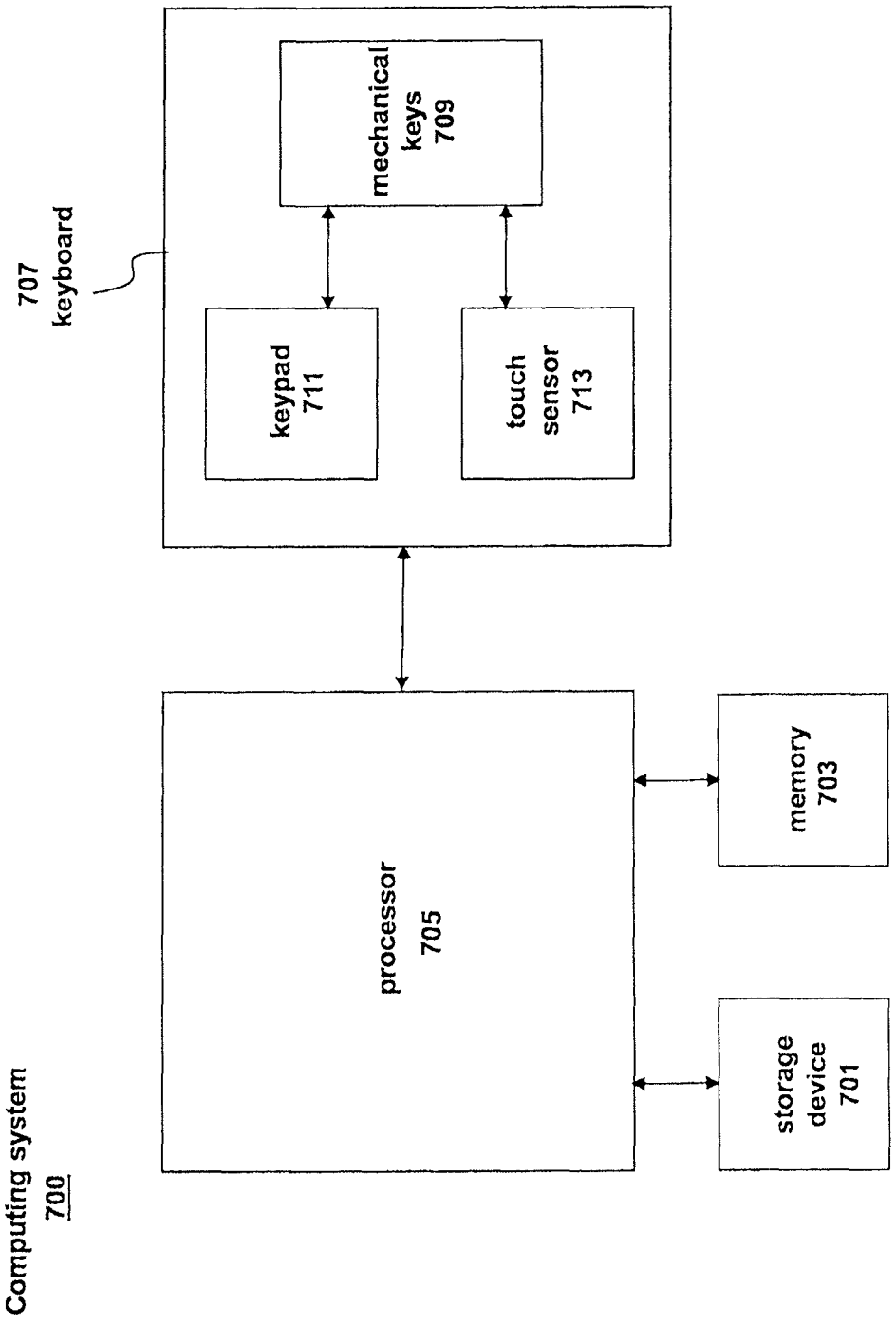

Computing system
700
processor
705
storage device
701
memory
703
707
keyboard
keypad
711
touch sensor
713
mechanical keys
709

FIG. 7

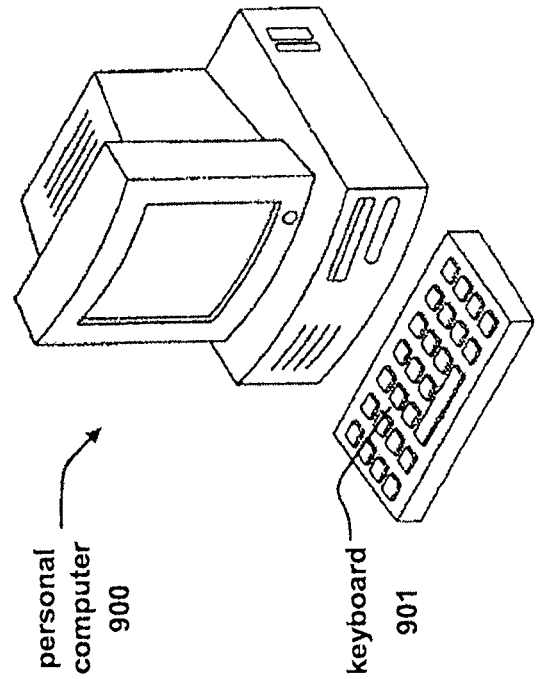

personal computer
900
keyboard
901

FIG. 9

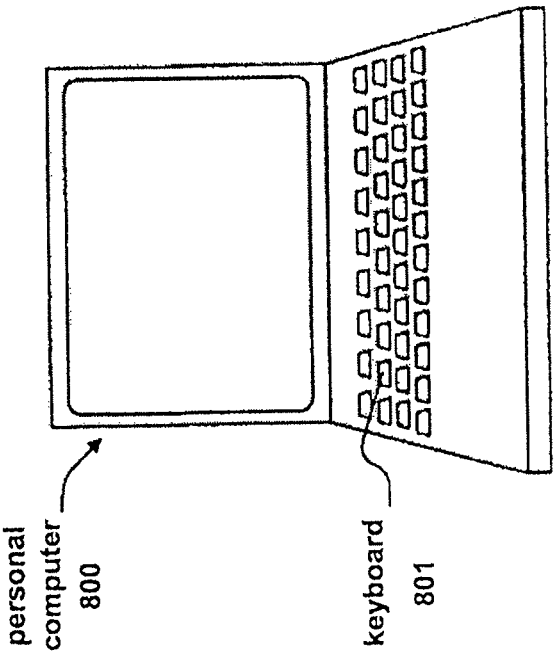

personal computer
800
keyboard
801

FIG. 8

ENABLING TOUCH EVENTS ON A TOUCH SENSITIVE MECHANICAL KEYBOARD

FIELD

This relates generally to input devices and, more specifically, to touch-sensitive input devices.

BACKGROUND

Keyboards are widely used and are generally accepted as the preferred way to provide textual input to a computing system. These keyboards typically have mechanical keys that are arranged in the so-called QWERTY layout and are configured to move independently of one another and comply with standards for key spacing and actuation force.

One of the most common keyboard types is a "dome-switch" keyboard that works as follows. When a key is depressed, the key pushes down on a rubber dome sitting beneath the key. The rubber dome collapses, giving tactile feedback to the user depressing the key, and causes a conductive contact on the underside of the dome to touch a pair of conductive lines on a Printed Circuit Board (PCB) below the dome, thereby closing the switch. A chip in the keyboard emits a scanning signal along the pairs of lines on the PCB to all the keys. When the signal in one pair of the lines changes due to the contact, the chip generates a code corresponding to the key connected to that pair of lines. This code is sent to the computer either through a keyboard cable or over a wireless connection where it is received and decoded into the appropriate key. The computer then decides what to do on the basis of the key depressed, such as display a character on the screen or perform some action. Other types of keyboards operate in a similar manner, with the main differences being how the individual key switches work. Some examples of other keyboards include capacitive-switch keyboards, mechanical-switch keyboards, Hall-effect keyboards, membrane keyboards, roll-up keyboards, and the like.

There have been numerous attempts made to introduce an alternative to the standard keyboard. The changes include, but are not limited to, non-QWERTY layouts, concave and convex surfaces, capacitive keys, split designs, membrane keys, etc. However, while such alternative keyboards may provide improved usability or ergonomics, they have failed to replace or duplicate the commercial success of the conventional mechanical keyboard.

SUMMARY

This relates to touch sensitive mechanical keyboards and processes for detecting touch events and key depressions on the touch sensitive mechanical keyboard. The touch sensitive mechanical keyboard can include a set of individually depressible mechanical keys having a touch sensitive area located on their surface. A touch sensor can be included within the keyboard to detect touch events on the surface of the mechanical keys. A keypad can also be included within the keyboard to detect a depression of one or more of the mechanical keys. In some embodiments, the touch sensitive mechanical keyboard can include a processor for distinguishing detected touch events from detected key depressions. The processor can generate either a touch event command or a key depression command. These will be described in more detail below.

Processes for detecting touch events and key depressions are also disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a top view of an exemplary touch sensitive mechanical keyboard according to various embodiments.

FIG. **2** illustrates an exemplary touch sensor panel that can be used with a touch sensitive mechanical keyboard according to various embodiments.

FIG. **3** illustrates an exploded view an exemplary touch sensitive mechanical keyboard according to various embodiments.

FIG. **4** illustrates a user performing a touch event on a surface of a key of a touch sensitive mechanical keyboard according to various embodiments.

FIG. **5** illustrates a user depressing a key of a touch sensitive mechanical keyboard according to various embodiments.

FIG. **6** illustrates an exemplary process for detecting touch events and key depressions of a touch sensitive mechanical keyboard according to various embodiments.

FIG. **7** illustrates an exemplary system including an input device according to various embodiments.

FIG. **8** illustrates an exemplary personal computer including an input device according to various embodiments.

FIG. **9** illustrates another exemplary personal computer including an input device according to various embodiments.

DETAILED DESCRIPTION

In the following description of example embodiments, reference is made to the accompanying drawings in which it is shown by way of illustration specific embodiments that can be practiced. It is to be understood that other embodiments can be used and structural changes can be made without departing from the scope of the various embodiments.

This relates to touch sensitive mechanical keyboards and processes for detecting touch events and key depressions on the touch sensitive mechanical keyboard. A touch event, such as a tap or a slide, may be detected when a finger or other object is placed near or in contact with a touch sensitive surface followed by a slide or when a finger or other object is placed near or in contact with the touch sensitive surface followed closely in time with a lift of the finger or object (tap). The touch sensitive mechanical keyboard can include a set of individually depressible mechanical keys having a touch sensitive area located on their surface. A touch sensor can be included within the keyboard to detect touch events on the surface of the mechanical keys. A keypad can also be included within the keyboard to detect a depression of one or more of the mechanical keys. In some embodiments, the touch sensitive mechanical keyboard can include a processor for distinguishing detected touch events from detected key depressions. The processor can generate either a touch event command or a key depression command. These will be described in more detail below. The touch sensitive mechanical keyboard can advantageously allow users to enter textual input using a device having the same look and feel of a conventional keyboard while allowing the users to enter touch events without requiring the users to remove their hands from the keyboard. Processes for detecting touch events and key depressions are also disclosed.

Although various embodiments describe touch events, it is to be understood that hover events can be detected as well.

FIG. **1** illustrates an exemplary touch sensitive mechanical keyboard **100** having mechanical keys **101** and a touch sensitive area located on the surfaces of mechanical keys **101**. In some embodiments, keyboard **100** can be configured to have the look and feel of a conventional keyboard. For instance, each mechanical key **101** can be individually depressible, giving the user of keyboard **100** tactile feedback associated with each depression of a key. Mechanical keys **101** can be used for text entry in a manner similar to a conventional keyboard. Additionally, the touch sensitive area of keyboard **100** can be used to detect touch events, such as taps or slides, on the surface of mechanical keys **101**. In this way, keyboard **100** can also be used for cursor input functions, such as point, click, scroll, drag, select, zoom, and the like, without requiring the user to remove their hands from keyboard **100**. These functions, and more, can be driven by hand/finger motion while the fingers are sliding over and touching mechanical keys **101**.

In some embodiments, the touch sensitive area of keyboard **100** can include the surfaces of all mechanical keys **101**. In other embodiments, the touch sensitive area can include the surfaces of only a portion of mechanical keys **101**. By integrating multi-touch input capability into keyboard **100** without altering its overall appearance or, more importantly, the familiar way in which it is used for typing, many of the benefits of multi-touch gesture-based input capability can be realized without having any negative impact on the user's text entry experience.

In some embodiments, keyboard **100** can further include mechanical key flexible printed circuit (FPC) **103**, first touch sensor FPC **105**, and second touch sensor FPC **107** for coupling keyboard **100** to a processor or host computer system. For example, mechanical key FPC **103** can be used by keyboard **100** to output information relating to the depression of one or more of mechanical keys **101**. Specifically, a signal indicating that one or more mechanical keys **101** have been depressed can be transmitted through mechanical key FPC **103** to a processor. Similarly, first and second touch sensor FPCs **105** and **107** can be used to output or receive information relating to a touch sensor included within keyboard **100**. For example, in some embodiments, keyboard **100** can include a capacitive touch sensor having multiple drive lines and multiple sense lines. In these embodiments, one of first touch sensor FPC **105** and second touch sensor FPC **107** can be used to receive stimulation signals for driving the drive lines while the other touch sensor FPC can be used to transmit touch signals received on the sense lines. In other embodiments, two or more of mechanical key FPC **103**, first touch sensor FPC **105**, and second touch sensor FPC **107** can be combined into a single FPC.

While specific examples of touch sensitive mechanical keyboard **100** are provided above, it should be appreciated that the principals described in the present disclosure can similarly be applied to touch sensitive mechanical keyboards having other features and configurations.

FIG. **2** illustrates a portion of an exemplary touch sensor **200** that can be used to detect touch events on touch sensitive mechanical keyboard **100**. Touch sensor **200** can include an array of pixels **205** that can be formed at the crossing points between rows of drive lines **201** (D**0**-D**3**) and columns of sense lines **203** (S**0**-S**4**). Each pixel **205** can have an associated mutual capacitance Csig **211** formed between the crossing drive lines **201** and sense lines **203** when the drive lines are stimulated. The drive lines **201** can be stimulated by stimulation signals **207** provided by drive circuitry (not shown) and can include an alternating current (AC) waveform. The sense lines **203** can transmit touch or sense signals **209** indicative of a touch at the panel **200** to sense circuitry (not shown), which can include a sense amplifier for each sense line.

To sense a touch at the touch sensor **200**, drive lines **201** can be stimulated by the stimulation signals **207** to capacitively couple with the crossing sense lines **203**, thereby forming a capacitive path for coupling charge from the drive lines **201** to the sense lines **203**. The crossing sense lines **203** can output touch signals **209**, representing the coupled charge or current. When a user's finger (or other object) touches the panel **200**, the finger can cause the capacitance Csig **211** to reduce by an amount ΔCsig at the touch location. This capacitance change ΔCsig can be caused by charge or current from the stimulated drive line **201** being shunted through the touching finger to ground rather than being coupled to the crossing sense line **203** at the touch location. The touch signals **209** representative of the capacitance change ΔCsig can be transmitted by the sense lines **203** to the sense circuitry for processing. The touch signals **209** can indicate the pixel where the touch occurred and the amount of touch that occurred at that pixel location. As discussed above, in some embodiments, stimulation signals **207** and touch signals **209** can be received and transmitted via first and second touch sensor FPCs **105** and **107**.

While the embodiment shown in FIG. **2** includes four drive lines **201** and five sense lines **203**, it should be appreciated that touch sensor **200** can include any number of drive lines **201** and any number of sense lines **203** to form the desired number and pattern of pixels **205**. Additionally, while the drive lines **201** and sense lines **203** are shown in FIG. **2** in a crossing configuration, it should be appreciated that other configurations are also possible to form the desired pixel pattern. While FIG. **2** illustrates mutual capacitance touch sensing, other touch sensing technologies may also be used in conjunction with embodiments of the disclosure, such as self-capacitance touch sensing, resistive touch sensing, projection scan touch sensing, and the like. Furthermore, while various embodiments describe a sensed touch, it should be appreciated that the touch sensor **200** can also sense a hovering object and generate hover signals therefrom.

FIG. **3** illustrates an exploded view of an exemplary touch sensitive mechanical keyboard **300**. Touch sensitive mechanical keyboard **300** is an example of touch sensitive mechanical keyboard **100** and includes a touch sensor similar to touch sensor **200** for detecting touch events on the surface of some or all of the mechanical keys (not shown) of keyboard **300**. Keyboard **300** can further include keypad **301** for detecting a depression of one or more of the mechanical keys of keyboard **300**. In some embodiments, keypad **301** can include multiple dome-switches that are configured to couple pairs of conductive lines on a PCB below each dome to detect depression of one or more of the mechanical keys. Keyboard **300** can further include a processor (not shown) that emits a scanning signal along the pairs of lines on the PCB to all the keys. When the signal in one pair of the lines changes due to coupling by the dome-switch, the processor generates a code corresponding to the key connected to that pair of lines. This information can be transmitted through mechanical key FPC **103** to a processor or computing device, such as a laptop computer, desktop computer, mobile device, mobile phone, or the like.

In other embodiments, keypad **301** can detect depression of mechanical keys using other technologies, such as capaci-

tive-switch circuitry, mechanical-switch circuitry, Hall-effect sensors, and the like. It should be appreciated that any known method for detecting depression of mechanical keys can be used.

Keyboard **300** can further include a touch sensor FPC layer **305** containing touch sensor circuitry for detecting touch events on the surface of the mechanical keys. Touch sensor FPC layer **305** can be applied to keypad **301** using an adhesive layer, such as pressure sensitive adhesive (PSA) **303**. Touch sensor FPC layer **305** can be located beneath keycaps **309**, and can be applied to keycaps **309** using an adhesive layer, such as pressure sensitive adhesive (PSA) **307**. Keycaps **309** can include multiple discrete portions forming the front surface of the mechanical keys. The surface of keycaps **309** can include printed or engraved letters, symbols, or numbers. When depressed, the keycaps **309** can directly or indirectly contact the keypad **301** through touch sensor FPC layer **305**, causing keypad **301** to detect the depression of the mechanical keys.

In some embodiments, touch sensor FPC layer **305** can include clusters of intersecting drive lines and sense lines forming sensor nodes similar to drive lines **201**, sense lines **203**, and pixels **205** of touch sensor **200** shown in FIG. **2**. Each mechanical key can have associated therewith any number of sensor nodes depending on the desired touch resolution. For example, the drive lines and sense lines can form a grid beneath each keycap **309** to detect touch events along the surface of keycaps **309**. To allow the depression of the mechanical keys to be detected by keypad **301**, touch sensor FPC layer **305** can be configured to allow a portion of keycaps **309** to directly or indirectly contact keypad **301**. For instance, in some embodiments, a plunger located on the bottom of keycaps **309** can be allowed to protrude through touch sensor FPC layer **305**. In these embodiments, touch sensor FPC layer **305** can be formed from a stretchable or deformable material to allow depression of the keys through FPC layer **305**. Alternatively, in other embodiments, FPC layer **305** can be positioned below keypad **301**. Since, in these embodiments, key caps **309** can directly or indirectly contact keypad **301** without protruding through FPC layer **305**, FPC layer **305** can be formed from non-stretchable or non-deformable materials.

Touch sensor FPC layer **305** can further include first and second touch sensor FPCs **105** and **107** for outputting and receiving signals associated with the operation of touch sensor FPC layer **305**. For example, one of first touch sensor FPC **105** and second touch sensor FPC **107** can be used to receive stimulation signals for driving the drive lines of touch sensor FPC layer **305** while the other touch sensor FPC can be used to transmit touch signals received on the sense lines of touch sensor FPC layer **305**. These signals can be transmitted to, and received from, a processor or other computing device, such as a laptop computer, desktop computer, and the like. In some embodiments, the processor coupled to touch sensor FPC layer **305** can be the same processor coupled to keypad **301**.

As discussed above, keyboards **100** and **300** can be capable of receiving both mechanical key depression input and touch event input. As a result, keyboards **100** and **300** can output two streams of information: a first data stream containing signals representative of a detected depression of one or more mechanical keys via mechanical key FPC **103** and a second data stream containing signals representative of one or more detected touch events via first touch sensor FPC **105** or second touch sensor FPC **107**. When a user contacts a surface of a mechanical key, touch sensor FPC layer **305** can report a detected touch event. However, when a key is depressed, both touch sensor FPC layer **305** and keypad **301** can report a detected event. Specifically, touch sensor FPC layer **305** can report a detected touch event and keypad **301** can report a detected key depression.

To illustrate, FIG. **4** shows a user inputting a touch event by applying finger **401** to the surface of keycap **309** without exerting sufficient downward force to depress dome-switch **403**. This action can cause the touch sensor, such as touch sensor FPC layer **305**, to detect the touch event and transmit a signal indicative of a detected touch event via touch sensor FPC **105** or **107**. Since the dome-switch **403** is not depressed, the keypad may not transmit a signal indicative of a depression of mechanical key **101**. Similarly, when a user enters a hover event by placing their finger near the surface of keycap **309**, the touch sensor may transmit a signal indicative of a detected hover event via touch sensor FPC **105** or **107**. Additionally, since the dome-switch **403** is not depressed, the keypad may not transmit a signal indicative of a depression of mechanical key **101**.

FIG. **5** shows a user entering a key stroke by applying finger **401** to the surface of keycap **309** and exerting downward force sufficient to depress dome-switch **403**. This action can cause dome-switch **403** to transmit a signal indicative of a depression of mechanical key **101** via mechanical key FPC **103**. However, since the user's finger **401** also contacts keycap **309**, the touch sensor, such as touch sensor FPC layer **305**, can detect the touch event and transmit a signal indicative of a detected touch event via touch sensor FPC **105** or **107**. Thus, in this example, both a touch event signal and a key depression signal can be transmitted from the touch sensitive mechanical keyboard.

FIG. **6** shows an exemplary process **600** for detecting touch events and key depressions on a touch sensitive mechanical keyboard similar or identical to touch sensitive mechanical keyboards **100** or **300**. Additionally, process **600** can provide a way to distinguish between touch events and key depressions on a touch sensitive mechanical keyboard.

At block **601** of process **600**, the surface of some or all of the mechanical keys of a touch sensitive mechanical keyboard can be monitored for a touch event. In some embodiments, a touch sensor similar or identical to touch sensor **200** or touch sensor FPC layer **305** can be used to detect touch events on or near the surface of mechanical keys **101**. If no touch event is detected, the process can repeat back to block **601** where the surface of some or all of mechanical keys **101** can continue to be monitored. However, if a touch event is detected, the process can proceed to block **605**. In some embodiments, if a touch event is detected, the touch sensor of the touch sensitive mechanical keyboard can transmit a signal indicating that a touch event has occurred as well as information relating to the touch event (e.g., location, duration, motion, or the like). For example, a touch event signal can be transmitted by touch sensor **200** or touch sensor FPC layer **305** to a processor via first or second touch sensor FPC **105** or **107**. The processor can be located within the touch sensitive mechanical keyboard or can be located separate from the touch sensitive mechanical keyboard.

Similarly, at block **603** of process **600**, the mechanical keys of a touch sensitive mechanical keyboard can be monitored for a depression of one or more of the mechanical keys. In some embodiments, a keypad similar or identical to keypad **301** can be used to detect a depression of one or more mechanical keys **101** of keyboard **100** or **300**. If no key depression is detected, the process can repeat back to block **603** where the mechanical keys **101** can continue to be monitored. However, if a key depression is detected, the process can proceed to block **605**. In some embodiments, if

a depression of one or more mechanical keys are detected, the keypad of the touch sensitive mechanical keyboard, such as keyboard **100** or **300**, can transmit a signal indicating that a key depression has occurred as well as information relating to the key depression (e.g., key depressed, duration, or the like). For example, a key depression signal can be transmitted by keypad **301** to a processor via mechanical key FPC **103**. In some embodiments, the processor can be the same processor that receives the touch signal from touch sensor **200** or touch sensor FPC layer **305** via first or second touch sensor FPC **105** or **107**. In other embodiments, a separate processor can be used.

At block **605**, it can be determined whether only a touch event has been detected or if both a touch event and a key depression have been detected. If a touch event has been detected and no key depression has been detected, the process can proceed to block **607**. However, if both a touch event and key depression have been detected, the process can proceed to block **609**.

In some embodiments, a processor located in a host computer, in the keyboard assembly, or elsewhere, can be used to determine if only a touch event has been detected, or if both a touch event and a key depression have been detected. The processor can be the same processor used to receive the touch event signal and key depression signal described above. Alternatively, the processor can be a different processor than that used to receive the touch event signal and key depression signal described above. For example, in some embodiments, the processor can be coupled to receive touch and key depression signals from the sensors within touch sensitive mechanical keyboard (e.g., keyboard **100** or **300**) via a connector (e.g., FPCs **103**, **105**, and **107**).

In some embodiments, upon receipt of a signal indicating a touch event has been detected, the processor can wait a threshold length of time for a signal indicating a key depression has been detected. This can be done because when a user depresses a key to input a character, number, or symbol, the user's finger can contact the surface of the key, causing the touch sensor circuitry to detect the touch event. The touch sensor circuitry can then send a signal to the processor indicating a touch event has been detected. However, since the user is attempting to enter a keystroke, the key can also be depressed a short time after the user's finger contacts the surface of the key. This can cause the keypad circuitry to detect the depression of the key and transmit a signal indicating that a key depression has been detected. Thus, to prevent the generation of excessive or erroneous signals, the processor may wait a threshold length of time after receiving the touch event signal to account for the delay between the user touching the key and the key being depressed. The threshold length of time may have a duration that is sufficiently long to allow the user to fully depress the key without causing a noticeable delay between the time the user presses the key and the time a computer system reacts to the input. Thus, if the key depression signal is received within the threshold length of time after receiving the touch event signal, the input can be interpreted as a key depression and the process can proceed to block **609**. If, however, the key depression signal is not received within the threshold length of time after receiving the touch event signal, the input can be interpreted as a touch event and the process can proceed to block **607**.

It should be appreciated that the determination performed at block **605** can be done on a per-key basis. For example, if a touch event is detected on a particular key (e.g., the "F" key), it can be determined whether the same key (the "F" key) has been depressed. If the same key has been depressed, the process can proceed to block **609**. If, however, a different key is depressed (e.g., the "R" key), the input can be interpreted as a touch event on the "F" key and the process can proceed to block **607**. In this way, the touch sensitive mechanical keyboard can detect touch events on one portion of the keyboard while receiving textual input at another portion of the keyboard. For the different depressed key (e.g., the "R" key), the process **600** can repeat in order to interpret its input and eventually proceed to block **609**.

At block **607**, a touch event command, such as a tap or slide event command, can be transmitted. In some embodiments, a processor can transmit a signal to another processor or host computer indicating that a tap or slide has been received by the touch sensitive mechanical keyboard.

At block **609**, a key depression command identifying the depressed key can be transmitted. In some embodiments, a processor can transmit a signal to another processor or host computer indicating that a key depression has been received by the touch sensitive mechanical keyboard.

One or more of the functions relating to the detection of a touch event or key depression can be performed by a computing system similar or identical to computing system **700** shown in FIG. **7**. Computing system **700** can include instructions stored in a non-transitory computer readable storage medium, such as memory **703** or storage device **701**, and executed by processor **705**. The instructions can also be stored and/or transported within any non-transitory computer readable storage medium for use by or in connection with an instruction execution system, apparatus, or device, such as a computer-based system, processor-containing system, or other system that can fetch the instructions from the instruction execution system, apparatus, or device and execute the instructions. In the context of this document, a "non-transitory computer readable storage medium" can be any medium that can contain or store the program for use by or in connection with the instruction execution system, apparatus, or device. The non-transitory computer readable storage medium can include, but is not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus or device, a portable computer diskette (magnetic), a random access memory (RAM) (magnetic), a read-only memory (ROM) (magnetic), an erasable programmable read-only memory (EPROM) (magnetic), a portable optical disc such a CD, CD-R, CD-RW, DVD, DVD-R, or DVD-RW, or flash memory such as compact flash cards, secured digital cards, USB memory devices, memory sticks, and the like.

The instructions can also be propagated within any transport medium for use by or in connection with an instruction execution system, apparatus, or device, such as a computer-based system, processor-containing system, or other system that can fetch the instructions from the instruction execution system, apparatus, or device and execute the instructions. In the context of this document, a "transport medium" can be any medium that can communicate, propagate or transport the program for use by or in connection with the instruction execution system, apparatus, or device. The transport medium can include, but is not limited to, an electronic, magnetic, optical, electromagnetic or infrared wired or wireless propagation medium.

Computing system **700** can further include touch sensitive mechanical keyboard **707** coupled to processor **705**. Touch sensitive mechanical keyboard **707** can be similar or identical to touch sensitive mechanical keyboard **100** or **300** described above. In some embodiments, keyboard **707** can include mechanical keys **709**, keypad **711**, and touch sensor

713 for detecting touch events and key depressions and for providing signals indicating a detection of a touch event or key depression to processor **705**. In some embodiments, mechanical keys **709** can be similar or identical to mechanical keys **101**, keypad **711** can be similar or identical to keypad **301**, and touch sensor **713** can be similar or identical to touch sensor **200** or touch sensor FPC layer **305**, described above. Processor **705** can receive the detection signals from keyboard **707** and interpret them as touch events or key depressions in a manner similar or identical to that described above with respect to process **600**.

It is to be understood that the computing system is not limited to the components and configuration of FIG. **7**, but can include other or additional components in multiple configurations according to various embodiments. Additionally, the components of computing system **700** can be included within a single device, or can be distributed between two or more devices. For example, while processor **705** is shown separate from keyboard **707**, in some embodiments, processor **705** can be located within keyboard **707**.

FIG. **8** illustrates an exemplary personal computer **800** that can include a touch sensitive mechanical keyboard **801** according to various embodiments.

FIG. **9** illustrates another exemplary personal computer **900** that can include a touch sensitive mechanical keyboard **901** according to various embodiments.

The personal computers of FIGS. **8** and **9**, as well as other computing devices, can receive both touch input and mechanical key input by utilizing a touch sensitive mechanical keyboard according to various embodiments.

Although embodiments have been fully described with reference to the accompanying drawings, it is to be noted that various changes and modifications will become apparent to those skilled in the art. Such changes and modifications are to be understood as being included within the scope of the various embodiments as defined by the appended claims.

What is claimed is:

1. A method for generating a keyboard command signal, the method comprising:

monitoring a plurality of depressible keys for a plurality of touch events on a surface of one or more of the plurality of depressible keys;

monitoring the plurality of depressible keys for a depression of a key of the plurality of depressible keys; and

generating one or more command signals based on the monitoring of the plurality of depressible keys for touch events on the surface of one or more of the plurality of depressible keys and the monitoring of the plurality of depressible keys for the depression of the key of the plurality of depressible keys,

wherein each of the one or more command signals is a touch event command signal or a key depression command signal and each touch event corresponds to one respective command signal of the one or more command signals,

wherein a touch event command signal is generated in response to detecting a first touch event on the surface of the one or more of the plurality of depressible keys and detecting the depression of a key of the plurality of depressible keys within a threshold length of time from detecting the first touch event, wherein the one or more of the plurality of depressible keys at which the first touch event is detected is different than the depressed key.

2. The method of claim **1** further comprising:

receiving a touch event signal in response to a detection of a second touch event on the surface of one or more of the plurality of depressible keys; and

receiving a key depression signal in response to the detection of the depression of the key of the plurality of depressible keys.

3. The method of claim **2**, wherein generating one or more command signals further comprises:

generating the touch event command signal in response to receiving the touch event signal without receiving the key depression signal within a threshold length of time from receiving the touch event signal; and

generating the key depression command signal in response to receiving the key depression signal within the threshold length of time from receiving the touch event signal

wherein the one or more of the plurality of depressible keys at which the second touch event occurs is at the depressed key.

4. The method of claim **2**, wherein the second touch event occurs at the depressed key.

5. A method for generating a keyboard command signal, the method comprising:

receiving a touch event signal indicating that a touch event has been detected on a surface of a first key of a plurality of depressible keys;

determining whether a key depression signal is received within a threshold length of time from receiving the touch event signal; and

in response to the touch event signal, generating a command signal based on the determination, wherein the command signal is a touch event command signal or a key depression command signal, and wherein generating the command signal comprises:

generating the touch event command signal in response to a determination that the threshold length of time elapsed without receiving the key depression signal; and

generating the touch event command signal in response to a determination that the key depression signal is received within the threshold length of time from receiving the touch event signal, wherein the key depression signal indicates that a second key of the plurality of depressible keys has been depressed, and the first key and the second key are different keys.

6. The method of claim **5**, wherein the key depression signal is received from a switch sensor operable to detect the depression of the first key of the plurality of depressible keys.

7. The method of claim **5**, wherein generating the command signal comprises generating a key depression command signal in response to the key depression signal being received within the threshold length of time from receiving the touch event signal, the key depression command signal indicating that both the touch event has occurred and the first key has been depressed.

8. The method of claim **5**, wherein the touch event signal is received from an array of capacitive sensors.

9. A keyboard comprising:

a plurality of depressible keys;

a plurality of switch sensors operable to detect a depression of one or more of the plurality of depressible keys;

an array of capacitive sensors operable to detect a touch event on a surface of one or more of the plurality of depressible keys opposite the array of capacitive sensors; and

a processor configured to receive a touch event signal indicating that a touch event has been detected by the array of capacitor sensors on the surface of the plurality of depressible keys, the processor further configured to receive a key depression signal indicating that a depression of a key of the plurality of depressible keys has been detected by the plurality of switch sensors,

wherein the processor is operable to generate a command signal based at least in part on the touch event signal, and the command signal is a touch event command signal or a key depression command signal,

wherein the processor is further operable to generate the touch event command signal in response to receiving the touch event signal, wherein the touch event occurs coextensive in time with the key of the plurality of depressible keys being depressed, and wherein the touch event and the depression occur at different keys of the plurality of depressible keys; and

wherein the processor is further operable to generate the key depression command signal in response to receiving the key depression signal coextensive in time with the touch event signal, wherein the touch event and the depression occur at a same key of the plurality of depressible keys.

10. The keyboard of claim **9**, wherein the processor is further operable to generate the touch event command signal in response to receiving the touch event signal without receiving the key depression signal within the threshold length of time from receiving the touch event signal.

11. The keyboard of claim **9**, wherein the keyboard is incorporated within a computing device.

12. The keyboard of claim **9**, wherein the keyboard is coupled to a computing device.

13. An apparatus comprising:

a surface having a plurality of locally collapsible areas;

a plurality of switch sensors operable to detect a depression of one or more of the locally collapsible areas;

an array of capacitive sensors operable to detect a touch event on the surface; and

a processor configured to receive a touch event signal indicating that a touch event has been detected by the array of capacitor sensors on a surface of the plurality of locally collapsible areas, the processor further configured to receive a depression signal indicating that a locally collapsible area of the plurality of locally collapsible areas has been depressed, wherein the processor is operable to generate a command signal in response to and based at least in part on the touch event signal, wherein the command signal is a touch event command signal or a key depression command signal,

wherein the processor is further operable to:

generate the key depression command signal in response to receiving the depression signal wherein the touch event occurs coextensive in time with the locally collapsible area being depressed, and the touch event and the depression occur at a same locally collapsible area; and

generate the touch event command signal in response to receiving the touch event signal, wherein the touch event occurs coextensive in time with the locally collapsible area being depressed, and the touch event and the depression occur at different locally collapsible areas.

14. The apparatus of claim **13**, wherein the touch event and the depression occur at the same locally collapsible area.

* * * * *